

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 26 JAN 2010 has been entered.

Response to Amendment

2. Examiner notes the amendment filed 26 JAN 1010. The amendment introduces no new matter and is therefore accepted. As a result of the amendment Claims 1, 5-6 and 9 are pending; Claim 1 has been amended.

Response to Arguments

3. Applicant's arguments filed 26 JAN 2010 have been fully considered but they are not persuasive.

4. Applicant's first argument is that lead or bismuth is not supplied at less than 5% excess value as required by stoichiometry. Examiner respectfully disagrees and points to PG 0283 of Natori et al, teaching several formulas where the lead and/or bismuth is provided in exactly stoichiometric ratios.

5. Applicant's second argument is that a pressure of 9.9 atm is not taught. Examiner respectfully disagrees and points to PG 0272 of Natori et al, which teaches a range inclusive of 9.9 atm.

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6. Applicant's third argument is that a specific temperature rise of at least 50 degrees Celsius per second is not taught. Examiner respectfully disagrees and points to Column 12 Lines 29-32 of Cuchiario, which teaches using double that rate in order to perform rapid thermal annealing. This teaching was not originally applied to Claim 1, but since Claim 1 has been amended, the rejection will be modified to incorporate it.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

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consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1, 6 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Natori, et al. (United States Patent Application Publication US 2003/0020157 A1, hereafter Natori) in view of Maloney (U.S. Patent 6,365,236, hereinafter Maloney), Wu (United States Patent 6,393,210 B1), Perino (U.S. Patent 5,426,075, hereinafter '075) and Cuchiaro et al. (United States Patent 6,225,156 B1, hereafter Cuchiaro).

5. Regarding Claim 1, Natori teaches a method of manufacturing a ceramic film (see Paragraphs [0005] – [0009]), comprising: providing a treatment target in which a raw material body including a complex oxide and a metal material including lead or bismuth included in the complex oxide at stoichiometric ratios is applied to a substrate (see, e.g., Paragraphs [0061] – [0070], Paragraphs [0281] – [0283] and [0328] – [0330], Paragraphs [0336] – [0339], and Claims 15, 16, and 17); holding the treatment target in a chamber (PG 0272-0275); supplying a gas which includes at least an oxidizing gas to the chamber (PG 0272-0275); and crystallizing the raw material body by increasing pressure of the gas in the chamber to a predetermined pressure of 9.9 atmospheres and heating the treatment target to a second temperature in the chamber by a heat treatment (see, e.g., Paragraphs [0272], [0273], and especially [0275]).

6. Natori does not explicitly teach that the heat source is outside the chamber. Maloney teaches a method for forming a multi-layered ceramic stack with different porosities between the layers and notes that for providing heat to the substrate, external heaters may be used (Column 5 Lines 10-47, most notably Lines 33-37). Therefore, it

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would have been obvious to a person having ordinary skill in the art at the time the invention was made to have combined the methods of Natori and Wu, as Natori wants to form ceramic films on substrates and Wu teaches a method for doing so wherein the substrate is heated by external sources.

7. Natori/Maloney does not explicitly teach the method of wherein the gas is supplied to the chamber after being heated to a first temperature in advance. However, Wu teaches just such a limitation in the heat treatment of semiconductor substrates. Specifically, Wu teaches, in Column 5, lines 7 – 20, that “the method and apparatus of this invention can be used in many different heat treatment applications in which a gas composition is employed to flow through the object being treated ... The method can ... be used in the thermal annealing of ion or dopant implanted semiconductor wafer, sintering metal contacts to enhance the metal-semiconductor contact after the deposition of metal film, ... and the like.” Wu further teaches, in Column 6, lines 25 – 46, that “the preheat unit preheats a gas composition used in the thermal processing of a wafer in the reactor. Gas compositions useful in the thermal processing of wafers are generally known in the art ... In a rapid thermal oxidation process, a gas composition having oxygen optionally in admixture with an inert gas is used.” Wu also teaches, in Column 3, lines 9 – 31, that “in accordance with the present invention, the gas composition is preheated before it is flushed into the rapid thermal processing chamber. Typically, the gas composition is heated to a preheat temperature that is sufficiently close to the operating temperature of the thermal processing chamber such that when the gas composition reaches the wafer being treated, its temperature is substantially

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same as the operating temperature. Preferably, the gas composition is preheated to the operating temperature before it flows into the processing chamber. Because the difference between the entering gas temperature and the operating temperature in a processing chamber is drastically reduced or even eliminated, when the gas composition flows into the processing chamber, it will not absorb any substantial amount of heat from the outer edge of the wafer being processed. Thus, the interference with the temperature uniformity on the wafer surface by the entering gas composition is minimized." Finally, Wu teaches, in Column 4, lines 9 – 13, that "by preheating the gas composition, the present invention significantly reduces the temperature difference, and improves the temperature uniformity on the wafer surface. As a result, less dislocation and distortion in the processed wafer is caused, and wafers with better qualities can be produced." Therefore, it would have been obvious to one having ordinary skill in the art at the time of the present invention to have modified the method taught by Natori by supplying the oxygen-containing sintering/annealing gas to the crystallizing/heat treatment chamber heated to the pre-determined process temperature in advance as taught by Wu, because Wu teaches that utilizing such a procedure results in improved temperature uniformity across the substrate and results in wafers/substrates with improved performance.

8. Natori/Maloney/Wu does not explicitly teach the method wherein a capacity of the chamber is 100 times or less of a volume of the substrate. However, both Natori (in Figure 22) and especially Wu (in Figures 1 and 2) show reactor chambers that are obviously less than 100 times the volume of the substrate. While these drawings are not

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necessarily to scale, it is the Examiner's position that the scales employed in these Figures would have reasonably indicated to one having ordinary skill in the art that reactors with volumes on the same order of magnitude as the volume of the wafer are typically employed. Moreover, Wu explicitly teaches, in Column 5, lines 28 – 30, that "conventional RTP reactors which generally process only one wafer at a time can be used." Therefore, it would have been obvious to one having ordinary skill in the art at the time of the present invention to have modified the method taught by Natori in view of Wu by utilizing a chamber having a capacity that is less than 100 times a volume of the substrate, because both Natori and Wu teach that such reactor sizes are typically employed in the art, and because reactor size is a known variable in process design and because minimizing process costs and reactor size are well known objectives of process design.

9. Natori teaches that the heat treatment is performed by using a rapid thermal annealing method (see Paragraphs [0342] and [0374]). In the alternative, Natori/Maloney/Wu does not explicitly teach that the rapid thermal annealing takes place at pressures of two atmospheres or more. However, it would have been obvious to one having ordinary skill in the art at the time of the present invention to have modified the method taught by Natori by utilizing a heat treatment that is performed by using a rapid thermal annealing method in a gas which is pressurized at two atmospheres or more with a reasonable expectation of success, because Natori teaches that the heat treatment may be an annealing method performed in a pressurized, oxidizing atmosphere of 2 atmospheres or more and that the heat

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treatment may be a rapid thermal annealing method performed in an oxidizing atmosphere.

10. Natori/Maloney/Wu do not expressly teach that the bismuth perovskite formed therein is ferromagnetic. Natori teaches a structure of $(\text{Bi}_2\text{O}_2)^{2-} (\text{A}_{m-1}\text{B}_m\text{O}_{3m+1})^{2+}$ where A can be chosen to be bismuth, B can be chosen to be titanium, and m can be chosen to be 3 (PG 0106). Perino teaches that a layered compound of bismuth titanate, $\text{Bi}_4\text{Ti}_3\text{O}_{12}$, is ferromagnetic and is laid down using alternating layers of $(\text{Bi}_2\text{O}_2)^{2-}$ and a perovskite material; to balance the chemical equation to get bismuth titanate, the perovskite material must be deposited as $(\text{Bi}_2\text{Ti}_3\text{O}_{10})^{2+}$. This is the same compound as is formed in Natori and it is taught to be ferromagnetic. Therefore, it would have been obvious to a person having ordinary skill in the art at the time the invention was made to have combined the teachings of Natori/Maloney/Wu and Perino as both teachings want to deposit the same bismuth perovskite on a surface for use in dielectric capacitor applications.

11. Natori teaches the concept of rapid thermal annealing (RTA) (see Paragraphs [0342] and [0374]), but does not teach the method wherein the treatment target is heated to the second temperature at a temperature rise rate of 50 C/sec or more. However, Cuchiario teaches just such limitations, wherein "a ferroelectric coating [is] crystallized using rapid-thermal processing, sometimes referred to as rapid-thermal-annealing (RTA) in which the wafer ... [is] raised to temperature at a rate of 100 C/sec" (see Column 12, lines 29 – 32). Therefore, it would have been obvious to one having ordinary skill in the art at the time of the present invention to have modified the method

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taught by Natori/Maloney/Wu/Perino by utilizing a heat treatment using a rapid thermal annealing method in which the treatment target is heated from the predetermined temperature at a temperature rise rate of 50 C/sec or more as taught by Cuchiario, because Cuchiario teaches that it is known in the art to form ceramic films including complex oxides by performing crystallization via RTA with temperature ramp rates of 100 C/sec.

12. Regarding Claim 6, Natori/Maloney/Wu/Perino/Cuchiario does not explicitly teach the method wherein the gas is supplied to the chamber after being heated in advance to the first temperature of 200 C or less. However, Natori does teach, in Paragraphs [0336] – [0343], that substrate treatment, ceramic raw material liquid application, and solvent evaporation takes place at temperatures that are less than 200 C (e.g., 180 C for substrate surface treatment in Paragraph [0338], and 160 C for solvent evaporation in Paragraph [0340]). Natori further teaches that crystallizing heat treatment takes place after these steps. As discussed for Claim 1, Wu teaches that it is known in the art to supply fluid streams to a unit operation at the temperature at which a process is taking place in order to more fully control the reaction or process. Therefore, it would have been obvious to one having ordinary skill in the art at the time of the present invention to have modified the method taught by Natori/Maloney/Wu by supplying the gas at a pre-heated temperature of 200 C or less, because Wu teaches that it is known to pre-heat fluid streams to a process temperature, and because Natori teaches that the steps immediately preceding the crystallizing heat treatment occur at temperatures less than 200 C.

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13. Regarding Claim 9, this claim is rejected on the same grounds as Claim 1, the range of 10 to 50 times the volume of the substrate being a subset of and therefore encompassed by the range of less than 100 times the volume of the substrate.

14. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Natori/Maloney/Wu/Perino/Cuchiario, and further in view of Rubey, et al. (United States Patent 5,846,293, hereafter Rubey).

15. Regarding Claim 5, Natori/Maloney/Wu/Perino/Cuchiario does not teach the method wherein pressure of the gas in the chamber is increased to the predetermined pressure of two atmospheres or more within 60 seconds. However, Rubey teaches that it is known in the art to achieve near instantaneous pressure changes in small reactor volumes. Rubey teaches, in Column 5, lines 27 – 45, that “After the sample has been admitted ... the rapid actuation switching valve is switched to high pressure gas source such that the sample receives a substantially instantaneous step-increase in pressurization to about 8.0 absolute atmospheres. By “step-increased pressurization”, it is meant that substantially instantaneous increase in pressure occurs from a low (but positive) pressure to a substantially higher pressure in a short amount of time (about 30 milliseconds).” Therefore, it would have been obvious to one having ordinary skill in the art at the time of the present invention to have modified the method taught by Natori/Maloney/Wu/Perino/Cuchiario by increasing the pressure of the gas in the chamber during heat treatment to the predetermined pressure of two atmospheres or more within 60 seconds as taught by Rubey, because Rubey teaches that is known to

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achieve such pressure increases in very short times via normal process design and because it is known in the art to control pressures and to minimize processing times.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL G. MILLER whose telephone number is (571)270-1861. The examiner can normally be reached on M-F 9-6.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Cleveland can be reached on (571) 272-1418. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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